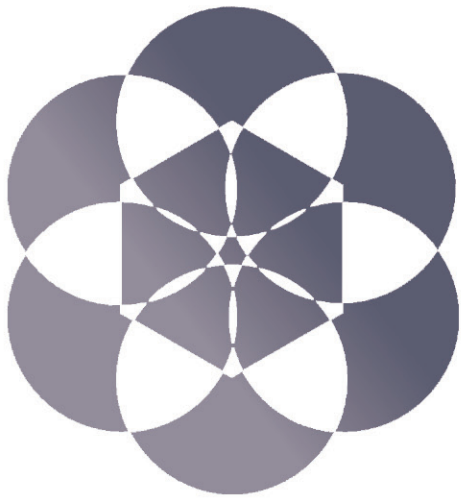
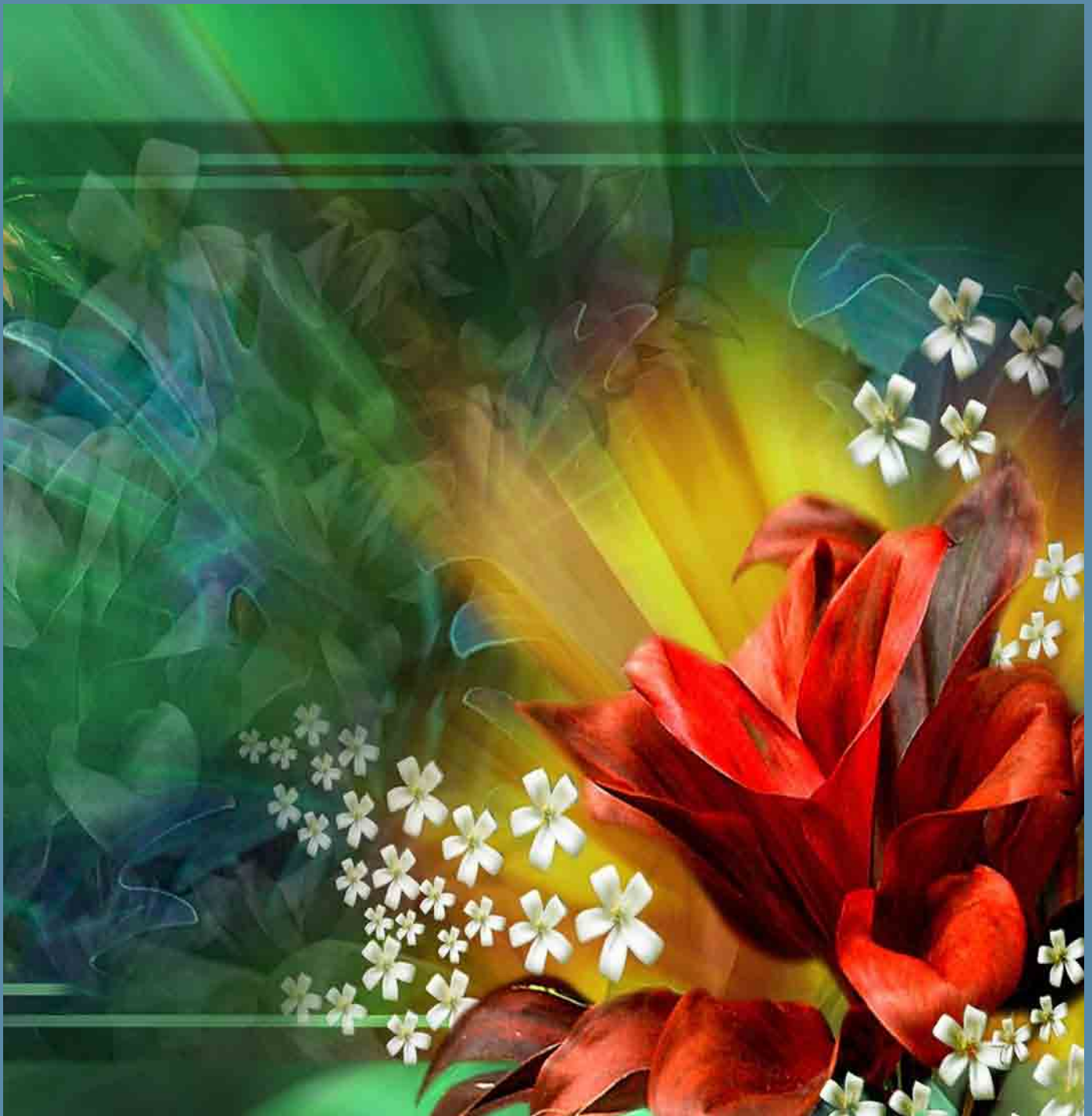


Spring 2011



Spheres

C (N) S I
California NANOSystems Institute



CNSI Seminar Series Presents:

Mark C. Hersam

Department of Materials Science and Engineering
Northwestern University



Chemically functionalized carbon nanomaterials

Carbon nanomaterials have attracted significant attention due to their potential to improve applications such as transistors, transparent conductors, solar cells, batteries, and biosensors. This talk will highlight our latest efforts to develop strategies for purifying, functionalizing, and assembling carbon nanomaterials into functional devices. For example, we have recently developed and commercialized a scalable technique for sorting surfactant-encapsulated single-walled carbon nanotubes (SWCNTs) by their physical and electronic structure using density gradient ultracentrifugation (DGU). The resulting monodisperse SWCNTs enhance the performance of thin film transistors, infrared optoelectronic devices, and transparent conductors. The DGU technique also enables multi-walled carbon nanotubes to be sorted by the number of walls, and solution phase graphene to be sorted by thickness, thus expanding the suite of monodisperse carbon nanomaterials. By extending our DGU efforts to carbon nanotubes and graphene dispersed in biocompatible polymers (e.g., DNA, Pluronic, Tetronics, etc.), new opportunities have emerged for monodisperse carbon nanomaterials in biomedical applications.

In addition to these solution-phase approaches, this talk will also discuss vacuum compatible methods for functionalizing the surfaces of carbon nanomaterials. For example, a suite of perylene-based molecules form highly ordered self-assembled monolayers (SAMs) on graphene via gas-phase deposition in ultra-high vacuum. Due to their noncovalent bonding, these SAMs preserve the superlattice electronic properties of the underlying graphene while providing uniform and tailorable chemical functionality. In this manner, disparate materials (e.g., high-k gate dielectrics) can be seamlessly integrated with graphene, thus enabling the fabrication of capacitors, transistors, and related electronic/excitonic devices. Alternatively, via aryl diazonium chemistry, functional polymers can be covalently grafted to graphene. In addition to presenting opportunities for graphene-based chemical and biological sensing, covalent grafting allows local tuning of the electronic properties of the underlying graphene.

Tuesday, April 5th 2011
4:00 PM - CNSI Auditorium
Reception to Follow

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CNSI Seminar Series Presents:

Xiangfeng Duan

Department of Chemistry and Biochemistry
Duan Group, Hetero-integrated Nanostructures and Nanodevices
University of California, Los Angeles



Rational Design and Nanoscale Integration of Multifunctional Nanostructures

Our research focuses on the rational design and nanoscale integration of highly complex inorganic nanostructures through chemical synthesis and/or physical assembly. A strong emphasis is placed on the hetero-integration of multi-composition, multi-structure and multi-function at nanoscale, with an aim to create a new generation of integrated nanosystems with unique functions or unprecedented performances that can break the boundaries of traditional technologies. In this seminar, I will discuss two recent examples. In a first example, I will discuss our ongoing effort in using chemical synthesis to hetero-integrate a nanoscale photovoltaic device with two redox catalysts in a single nanostructure to form a freestanding photoelectrochemical nanodevice. Our studies shows that such freestanding photoelectrochemical nanodevices can be used as highly efficient photocatalysts to harness solar energy and make use of photogenerated carriers on site to drive both thermodynamically downhill and uphill reactions, which may lead to exciting opportunities in artificial photosynthesis and solar fuel production. In a second example, I will briefly describe our recent effort in using a physical assembly approach to integrate graphene with a self-aligned nanowire gate to enable graphene transistors with unprecedented speed.

Tuesday, April 12th 2011
4:00 PM - CNSI Auditorium
Reception to Follow

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CNSI Seminar Series Presents:

Takhee Lee

Engineering Molecular Nanoelectronics Lab
Gwangju Institute of Science and Technology, Korea

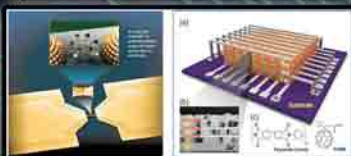


Molecular Transistors and Organic Memory Devices

Field-effect transistors (FETs) rely on the gated electrostatic modulation of the channel charge by changing the relative position of the conduction and valance bands with respect to the electrodes. In molecular-scale devices, a longstanding challenge has been the ability to create a true three-terminal device that operates in this manner. In this talk, I will demonstrate a direct electrostatic modulation of orbitals in a molecular transistor configuration, with both effective gate control and enhanced resonant coupling of the orbitals to the source and drain electrodes. Individual molecules are connected to source and drain electrodes with a bottom-gate control electrode in a FET configuration. We have examined two prototype molecules: the control, octanedithiol with an alkyl σ -backbone as a saturated aliphatic molecule, and the active device, benzenedithiol with a delocalized π -electron aromatic ring as a conjugated molecule. We observed the transport barrier for molecular transistors shifted to a lower bias as a more negative VG is applied, indicating that the molecular transistors behave as a p-type-like tunneling devices. Inelastic electron tunneling spectroscopy was also performed, to verify the identity of the molecules in the junction, and to determine the amount of orbital coupling.

In the second part of the talk, our recent research on the organic non-volatile memories will be briefly discussed. I will put special focus on important strategies to realize more practical memory devices in terms of memory performance enhancement, high density integration, and advanced architectural concepts. And, if time is allowed, I will also briefly discuss other research results on nanoscale logic circuits and graphene-electrode optoelectronic devices.

Figure. (Left) SEM images and schematic of a molecular transistor. (Right) Cross-sectional TEM image and schematic of three-dimensionally stacked organic resistive memory devices.



Tuesday, May 3rd 2011
4:00 PM - CNSI Auditorium
Reception to Follow

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CNSI Seminar Series Presents:

Dean Ho

Department of Biomedical and Mechanical Engineering
Robert H. Lurie Comprehensive Cancer Center
Northwestern University



Nanodiamond-Based Therapeutic Delivery Agents for Cancer Therapy

Nanodiamond (ND) surface properties mediate a spectrum of clinically-relevant improvements to drug delivery such as enhanced cancer treatment efficacy and safety. NDs can also be functionalized with a broad array of therapeutics which includes small molecules, proteins, antibodies, and DNA/siRNA for applications in cancer treatment, cardiovascular medicine, wound healing, and beyond. In addition, NDs possess uniform dimensions (~2-8 nm in diameter per particle) and material stability that are coupled with observed biocompatibility in vitro and in vivo. Furthermore, NDs can be batch purified and functionalized for scalable and high yield processing. Among other functional groups, NDs also possess an abundance of surface-bound carboxyl groups which are conducive towards facile, application-dependent molecular linking/conjugation onto the diamond surface. Furthermore, NDs can be functionalized with additional chemical species to enable direct drug conjugation. Our previous studies have confirmed robust drug binding to NDs through transmission electron microscopy (TEM) and Fourier transform infrared spectroscopy (FTIR) coupled with in vitro tracking of cellular internalization and quantitative demonstration of bio-amenable cell response through quantitative real time polymerase chain reaction (RT-PCR) assays of inflammatory and apoptosis-regulating gene expression programs. Towards the broadening of ND applicability in clinically-significant treatment scenarios, recent work pertaining to the in vivo validation of ND-based treatment of drug-resistant tumors as well as implantable/localized wound healing will be discussed.

Tuesday, May 10th, 2011
4:00 PM - CNSI Auditorium
Reception to Follow

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Spring 2011

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8 Photographs of Review Authors and Speakers

hersam Chemically Functionalized Carbon Nanomaterials



markHERSAM

Materials Science and
Engineering
Northwestern University

During his talk at CNSI, Mark Hersham explained how carbon nanomaterials have attracted significant attention because of their potential to improve such systems as transistors, transparent conductors, solar cells, batteries, and biosensors. Hersham's talk highlighted the latest efforts to develop strategies for purifying, functionalizing, and assembling carbon nanomaterials into functional devices. One example is the recent development and commercialization of a scalable technique for sorting surfactant-encapsulated single-walled carbon nanotubes (SWCNTs) in terms of their physical and electronic structures using density gradient ultracentrifugation (DGU). The resulting monodisperse SWCNTs enhance the performance of thin film transistors, infrared optoelectronic devices, and transparent conductors. The DGU technique also enables multi-walled carbon nanotubes to be sorted in terms of the number of walls, and solution-phase graphene to be sorted in terms of its thickness, thereby expanding the suite of monodisperse carbon nanomaterials. By extending their DGU efforts to carbon nanotubes and graphene dispersed in biocompatible polymers (e.g., DNA, Pluronics,

Tetronics), new opportunities have emerged for monodisperse carbon nanomaterials in biomedical applications.

In addition to these solution-phase approaches, Hersham also discussed vacuum-compatible methods for functionalizing the surfaces of carbon nanomaterials. For example, a suite of perylene-based molecules form highly ordered self-assembled monolayers (SAMs) on graphene during gas-phase deposition in ultra-high vacuum. Because they form through noncovalent bonding, these SAMs preserve the superlative electronic properties of the underlying graphene while providing uniform and tailorable chemical functionality. In this manner, disparate materials (e.g., high- k gate dielectrics) can be seamlessly integrated with graphene, thereby enabling the fabrication of capacitors, transistors, and related electronic/excitonic devices. Alternatively, using aryl diazonium chemistry, functional polymers can be covalently grafted onto graphene. In addition to presenting opportunities for graphene-based chemical and biological sensing, covalent grafting allows local tuning of the electronic properties of the underlying graphene.

Rational Design and Nanoscale Integration of Multifunctional Nanostructures

Dr. Xiangfeng Duan's research group focuses on the rational design and nanoscale integration of highly complex inorganic nanostructures through chemical synthesis and/or physical assembly. A strong emphasis is placed on the hetero-integration of multi-composition, multi-structure, and multi-function at the nanoscale, with an aim to create a new generation of integrated nanosystems with unique functions or unprecedented performances that can break the boundaries of traditional technologies. In this seminar, Duan described two recent examples. In the first, chemical synthesis is being used to hetero-integrate a nanoscale photovoltaic device with two redox catalysts in a single nanostructure to form a freestanding photoelectrochemical nanodevice. Duan's group has demonstrated that such freestanding photoelectrochemical nanodevices can be used as highly efficient photocatalysts to harness solar energy and make use of photogenerated carriers on-site to drive both thermodynamically downhill and uphill reactions, potentially leading to exciting opportunities in artificial photosynthesis and solar fuel production. In the second example,

Duan described his recent effort at using a physical assembly approach to integrate graphene with a self-aligned nanowire gate to enable graphene transistors with unprecedented speed.

Dr. Duan is an Assistant Professor at UCLA. He received a B.S. in chemistry from the University of Science and Technology in China in 1997 and a M.A. in chemistry and Ph.D. in physical chemistry from Harvard University in 1999 and 2002, respectively. From 2002 to 2008, he was a Founding Scientist, Principal Scientist, and Manager of Advanced Technology at Nanosys Inc., a nanotechnology startup founded based partly on his doctoral research. In 2008, he joined the Department of Chemistry and Biochemistry, University of California, Los Angeles. Dr. Duan's research focuses on fundamental studies of functional nanostructures and nanodevices, and the exploration of their potential for future electronics, energy science, and biomedical science. Dr. Duan has published over 50 technical papers in leading scientific journals, and holds more than 50 patents or patent applications.



xiangfengDUAN

Chemistry and Biochemistry
University of California,
Los Angeles

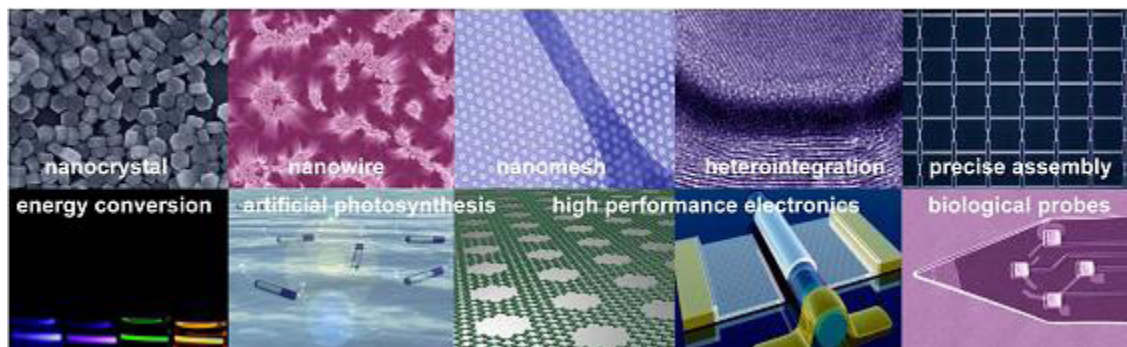


Figure 1. Research interests of Dr. Duan and his lab.

Organic and Molecular Electronics

By Kitty Cha

The research group headed by Professor Takhee Lee at the Gwangju Institute of Science and Technology has contributed to several developments in molecular and nanoscale electronic devices. Their research encompasses a very broad field, including memory devices from both organic and nanostructured materials; nanowire field effect transistors; and graphene growth and characterization. During his talk at CNSI, Professor Lee highlighted some of his group's recent research accomplishments. In the field of molecular electronics, the ultimate in electronic device miniaturization would be circuit elements comprising individual molecules. A recent achievement was the practical realization of a single-molecule transistor, in which a single molecule connected the source and drain electrodes (Figure 1a). The electric field created by the gate electrode modulated the molecular orbital energies in the molecule.

The Lee group analyzed the phenomena occurring in their devices using two techniques: inelastic electron tunneling spectroscopy and transition-voltage spectroscopy. The first technique revealed that the currents did indeed pass through the molecules in these transistors. The second confirmed a linear relationship between the applied gate voltage in the device and the molecular orbital energy. In fact, there is a very strong coupling existed between the gate voltage and the molecular orbital energy in the devices.

In organic polymer memory devices, specifically resistance-type memory devices, prevention of cross-talk interference is essential for practical applications. Cross-talk interference in memory devices, where a signal transmitted on one circuit crosses over to another circuit, can occur as a result of an excess of current inducing electrical

damage, or through leakage current paths (sneak paths) through neighboring cells with low resistances in cross-point array structures. This phenomenon disturbs the reading process of a particular device and must be eliminated to enable practical memory applications. To do so, a rectifying diode is added to each individual cell to construct a "1D-1R" device (Figure 1b). These 1D-1R memory devices possess both electrically rewritable switching characteristics and rectifying properties. Using this new transistor array architecture, the Lee group avoided cross-talk interference and enhanced the memory reading capabilities of their devices. Therefore, this structure may enable the application of high-density integrated organic memory devices. Other developments on the horizon are flexible organic memory devices, three-dimensional integrated assemblies, and smaller device sizes through the use of imprint fabrication methods.

Professor Lee also discussed his work on nanowire field-effect transistors; specifically, the interface defects in rough nanowires that cause charge transfer. Their complementary metal-oxide-semiconductor devices are constructed using carbon nanotubes and zinc oxide nanowires as the p- and n-type materials, respectively. The interfaces of these materials are tuned using high-energy

radiation.

Finally, the Lee group has applied graphene electrodes to organic solar cells and gallium nitride LEDs. An efficiency of about 2.6 % was recently achieved, the highest thus far for solar cells prepared with this material.

The Lee group's discoveries mark milestone developments in organic and molecular electronics, paving the way to wide-ranging commercial applications.

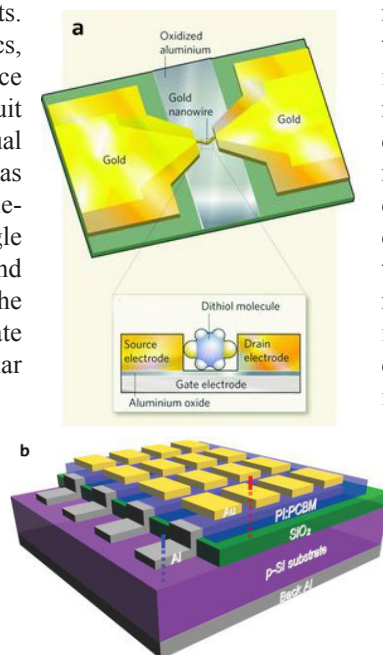


Figure 1. Schematic illustrations of (a) a molecular transistor and (b) a 1D-1R memory device. Images from <http://dx.doi.org/10.1002/adma.201004291/> and <http://dx.doi.org/10.1002/adma.200903203/>



takheeLEE

Engineering: Molecular Nanoelectronics Lab Gwangju Institute of Science and Technology,

ho Nanodiamonds for Drug Delivery

By Samuel Duan

The ability to poison cancer cells with drugs is of great interest, but it is very risky because healthy cells might also be ruined during treatment. Another hurdle to cancer treatment is resistance to chemotherapy. Sometimes a drug is flushed out by the cancer cell before it can begin to do its job. Scientists at Northwestern University, led by Dr. Dean Ho, have demonstrated that relatively new nanomaterials can shuttle chemotherapy drugs to cells without producing the negative effects of today's delivery agents. These agents are nanodiamonds (Figure 1).

These diamonds are not those found on our fingers and ears, but are instead a bunch of tiny carbon atoms. Actually, nanodiamonds are 2 nm in diameter in single-particle form, and can be manipulated to form clusters having diameters in the range of 50-100 nm. Such dimensions make them ideal for drug delivery by shielding and slowly releasing drugs trapped within the cluster of diamonds. In his talk at CNSI, Dr. Ho spoke about his group's work on using nanodiamonds as therapeutic delivery agents for cancer treatment. They have recently achieved the first significant results proving the potential of nanodiamonds in the

treatment of chemotherapy-resistant cancers.

In a recent study, Ho and his co-workers injected nanodiamonds that were covered with the drug doxorubicin into mice. The mice were affected with chemo-resistant breast and liver cancers. Surprisingly, the treatment did not decrease the white blood cell count, as the drug usually does; more importantly, no toxic effects on tissues were observed in the experiments. When they increased the dosage of doxorubicin (not bound to the nanodiamonds), all of the mice died before the treatment was complete. When they applied the same amount of doxorubicin bound to the nanodiamonds, not only did the mice survive, their tumors also shrank significantly.

Although the application of nanodiamonds to human use remains to be established, the ability to bind them to drugs for resultant treatment of chemo-resistant tumors suggests that nanodiamonds possess many of the characteristics required for a translationally relevant drug delivery. This behavior serves as a promising foundation for the continued development of nanodiamond therapies and potential clinical applications.



deanHo

Biomedical and Mechanical
Engineering
Northwestern University

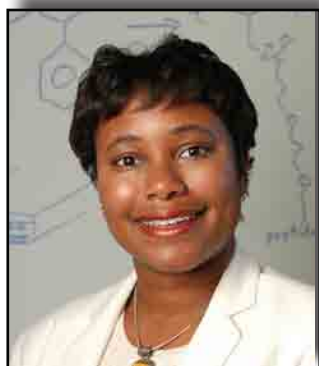


Figure 1. An illustration of a nanodiamond film.

Building Materials Nanolayer by Nanolayer: From Batteries to Implantable Pharmacies

hammond

By Jun Yang



Paula Hammond

Chemical Engineering: Koch Institute for Integrative Cancer Research Massachusetts Institute of Technology

Thin polymer films have important practical applications in areas ranging from corrosion protection to reverse osmosis. The films are traditionally fabricated by depositing them onto a substrate using such methods as spin- and dip-coating, interfacial polymerization, painting, spraying, and electrophoretic deposition. During the past 15 years, many researchers have developed methods for depositing functional thin films in a layer-by-layer (LBL) manner (Fig. 1). These methods involve alternating the adsorption of complementary materials, such as polycations and polyanions; such techniques are attractive because they afford nanometer-scale control over film thickness through variation of the number of deposited layers.

Prof. Hammond and coworkers use this method to manipulate the transport in and function of thin films, enabling the generation of a range of organic and organic/inorganic devices. For example, a novel solid-state thin film was generated with high conductivity, making the LBL system competitive for use in fuel cells and other applications of solid-state electrolytes. The studied LBL films are highly methanol-resistant, with permeabilities two orders of magnitude lower than that of conventional Nafion film. These highly conducting films have great potential for use in other electrochemical systems requiring highly conductive solid-state electrolytes (e.g., batteries, dye-sensitized photovoltaic cells, electrochromic devices, sensors).

LBL techniques have also been used to assemble an electrode that consists of additive-free, densely packed, functionalized multi-walled carbon nanotubes. The electrode, which is several micrometers thick, can store lithium up

to a reversible gravimetric capacity of 200 mA h g⁻¹ while also delivering 100 kW kg⁻¹ of power and providing lifetimes in excess of thousands of cycles; these features are comparable with those of electrochemical capacitor electrodes. A device using the nanotube electrode as the positive electrode and lithium titanium oxide as a negative electrode had a gravimetric energy five times higher than those of conventional electrochemical capacitors and a power delivery 10 times higher than those of conventional lithium-ion batteries.

Although the infection rate of orthopedic implants is low, the required treatment, which can involve six weeks of antibiotic therapy and two additional surgical operations, is life-threatening and expensive, thereby motivating the development of one-stage re-implantation procedures. Polyelectrolyte multilayers incorporating gentamicin were fabricated using the LBL deposition process for use as a device coating to address an existing bone infection in a direct implant exchange operation. The films eluted about 70% of their payload in vitro during the first three days and continued to release the drug for more than four additional weeks, reaching a total average release of over 550 mg cm⁻¹. After a direct exchange procedure, the antimicrobial-coated devices yielded bone homogenates with a significantly lower degree of infection than did uncoated devices at both day four (p < 0.004) and day seven (p < 0.03). Thus, a self-assembled ultrathin film coating is capable of effectively treating an experimental bone infection in vivo. This approach lays the foundation for the development of multi-therapeutic films for optimized, synergistic treatment of pain, infection, and osteomyelitis.

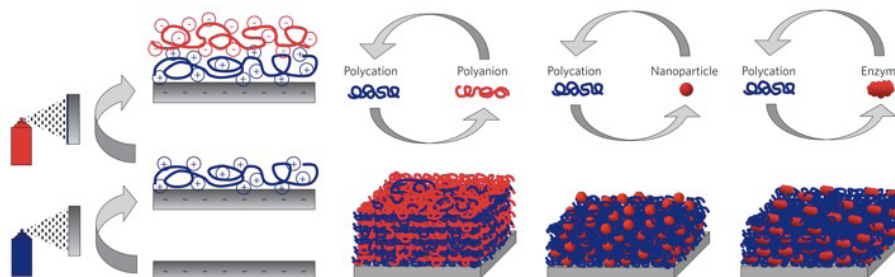


Fig.1: Layer-by-layer deposition of functional thin films.

vignale Electric Field Control of Spin-Waves

By Mircea Trif

Nanotechnology lies at the heart of future electronic devices because decreasing their sizes improves their functionality. This approach, however, does not come without costs, because most of the materials undergo drastic changes in their properties when reduced in size, compared with those of their bulk counterparts. One of the major challenges in the nanometer regime is that of dissipation. Classical electronics involves electrical currents, which inherently lead to heating via the Joule effect and, consequently, to the breakdown of devices when they are made smaller.

The discovery of giant magnetoresistance (GMR, Nobel Prize in 2007) in ferromagnetic/non-ferromagnetic layered systems initiated the field of spintronics, an alternative to the usual electronics, where the spin of the electron, instead of its charge, plays the key role of transporting and processing information. This research has led to a tremendous number applications, such as hard drives and magnetic sensors.

A major challenge in the field of spintronics is the ability to manipulate the magnetic moment and the spin current that carries it. In his talk at CNSI, Prof. Giovanni Vignale presented an original approach for controlling electrically, instead of magnetically, the magnetic moment of the magnetic insulator (more commonly known as yttrium iron garnet or YIG), in view of efficient future spintronic devices.

On the nanoscale, electric fields are preferred over magnetic fields because they can be made

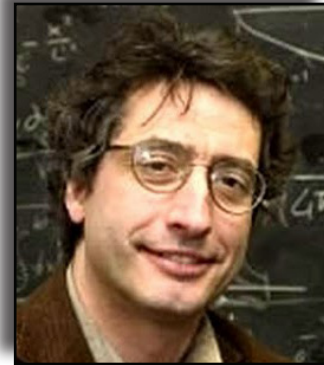
arbitrarily strong, can be applied locally, and can be switched very quickly using only local gates.

The transport of information in these systems is accomplished by the collective motion of the magnetic moment, so-called spin-waves or magnons, which do not dissipate energy via Joule heating and, moreover, can travel over distances of the order of centimeters before they scatter and lose the information they carry. The key point in Prof. Vignale's proposal is that there is no charge flow in the process, as opposed to the situation in more usual materials (e.g., magnetic metals, magnetic semiconductors).

The coupling of the electric field to magnons, as proposed, is due to a subtle interplay between the modification of the chemical bonding in electric fields and the strong spin-orbit interaction (SOI) present in YIG. SOI is a relativistic effect that gives rise to coupling of the electron spin to its orbital motion; it is a great resource in spintronics.

Based on general physical arguments, and supplemented by a rigorous microscopic model, Prof. Vignale revealed that reasonably strong coupling of the magnons to the electric field can be achieved using fields within current experimental reach (ca. 10^7 V m^{-1}).

In the last part of his talk, Prof. Vignale described an application of this proposal: an insulating magnetic ring interferometer, which, under the effect of an electric field, can act as a logic inverter and as a building block for room-temperature, low-dissipation logic circuits.



giovanniVIGNALE

Theoretical Condensed Matter Physics Research Group
University of Missouri-Columbia

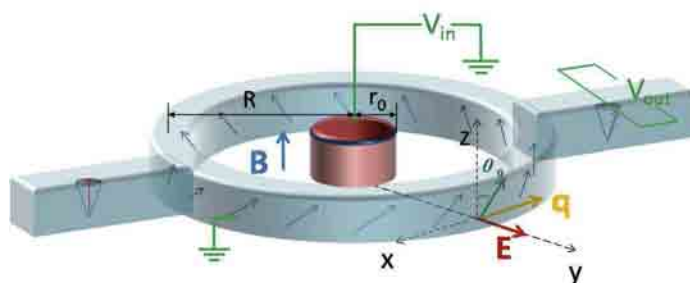


Fig.1: Spin-wave interferometer controlled by electric fields.

Review Authors and Speakers

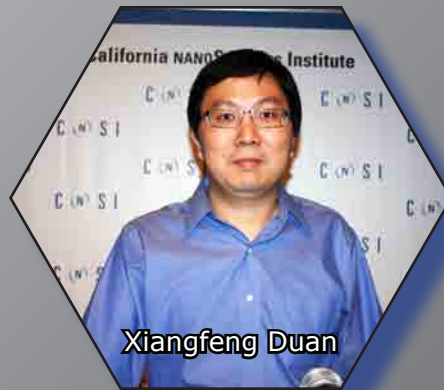


Mark Hersam



Takhee Lee

Kitty Cha



Xiangfeng Duan



Samuel Duan

Dean Ho



Mircea Trif

Giovanni Vignale



Jun Yang

Paula Hammond

CNSI Seminar Series Presents:

Paula T. Hammond

Department of Chemical Engineering
Koch Institute for Integrative Cancer Research
Massachusetts Institute of Technology
Associate Editor, ACS Nano



Building Materials Nanolayer by Nanolayer: From Batteries to Implantable Pharmacies

The alternating adsorption of oppositely charged molecular species, known as the electrostatic layer-by-layer (LbL) process, is a simple and elegant method of constructing highly tailored ultrathin polymer and organic-inorganic composite thin films. We use this method to manipulate transport and function in thin films, enabling the generation of a range of organic and organic-inorganic devices. Several approaches to the controlled manipulation, construction and, in some cases, the controlled deconstruction, degradation or dissolution of multilayers upon specific stimulus will be discussed. A modified form of the automated alternate misting approach is also useful for the incorporation of materials systems and the generation of complex thin film morphologies and architectures. New developments in the rapid assembly of these systems with nanoscale objects such as carbon nanotubes and functionalized nanoparticles, and their practical applications from biomedical implants and modular release vaccine systems to electrochemical energy devices will be addressed. Finally, new advances in the use of LbL to generate smart nanoparticle systems for targeting cancer will be described.

Tuesday, May 17th 2011
4:00 PM - CNSI Auditorium
Reception to Follow

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CNSI Seminar Series Presents:

Giovanni Vignale

Curators' Professor of Physics
Theoretical Condensed Matter Physics Research Group
University of Missouri-Columbia



Electric Control of Spin Currents and Spin-Wave Logic

There has been in recent years a tremendous growth of interest in the so-called spin-wave spintronics, in which spin waves - collective excitations of a magnetized material - are used in alternative to individual spin-polarized electrons to perform logical functions. The great appeal of the idea arises mainly from the fact that spin waves in insulating magnets can transport spin currents with extremely low energy dissipation. In this context, an interesting scheme of "spin-wave logic", in which logical operation are implemented at room temperature and GHz frequencies via constructive or destructive interference of spin waves, has been proposed and implemented by several experimental groups. (M. P. Kostylev [et al.], App. Phys. Lett. 87, 153501 (2005)) The essential element of any spin wave logic device is a spin-wave phase shifter. Phase shift can be achieved by a magnetic field (which changes the wave vector of the wave at given frequency), by a magnetic domain wall, or, more generally, by passing the spin wave through a non-uniform magnetic texture. In our work we introduce a new mechanism, in which the phase of spin waves is controlled by an electric field, via the spin-orbit coupling of this electric field to the electrons that mediate the magnetic interaction. We refer to this new mechanism as 'magneto-electric control of spin waves'. Our microscopic calculations, based on the super-exchange model of magnetism, indicate that the magneto-electric effect is sufficiently large to be used to effectively control spin currents. We apply these findings to the design of a novel spin-wave interferometric device, which works on a topological interference mechanism, analogous to the Aharonov-Casher effect for spin-carrying particles. This device can be used as a building block for room-temperature, low-dissipation logic circuits.

Tuesday, May 31st 2011
4:00 PM - CNSI Auditorium
Reception to Follow

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CALIFORNIA NANOSYSTEMS INSTITUTE

Seminar Series - Spring 2011

- 04-05-2011** **Mark C. Hersam**, Northwestern University
Department of Materials Science and Engineering
Topic: Chemically Functionalized Carbon Nanomaterials
- 04-12-2011** **Xiangfeng Duan**, University of California, Los Angeles (UCLA)
Department of Chemistry and Biochemistry
Topic: Rational Design and Nanoscale Integration of Multifunctional Nanostructures
- 05-03-2011** **Takhee Lee**, Gwangju Institute of Science and Technology, Korea
Department of Engineering: Molecular Nanoelectronics Lab
Topic: Molecular Transistors and Organic Memory Devices
- 05-10-2011** **Dean Ho**, Northwestern University
Department of Biomedical and Mechanical Engineering
Topic: Nanodiamond-Based Therapeutic Delivery Agents for Cancer Therapy
- 05-17-2011** **Paula T. Hammond**, Massachusetts Institute of Technology (MIT)
Department of Chemical Engineering
Topic: Building Materials Nanolayer by Nanolayer: From Batteries to Implantable Pharmacies
- 05-31-2011** **Giovanni Vignale**, University of Missouri
Department of Physics
Topic: Electric Control of Spin Currents and Spin-Wave Logic

Tuesdays 4:00pm
CNSI Auditorium
Reception to Follow
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